tench, rudd, roach and chub have been successfully introduced into waters at from 1000 to 1700 meters in altitude. *Gobius fluviatilis* has ascended the Po to the confines of Switzerland, and *Blennius cognata* occurs in abundance in Lake Maggiore and in the Lake of Bourget in Savoy.

Mammals.—MM. Pouchet and Beauregard have been led by the examination of a portion of the "case" containing the spermaceti of the cachalot, to emit the supposition that the "roots" of this case may be the analogue (homologue?) of the posterior region of the right nasal fossa, while the reservoirs situated anteriorly may represent the smooth part of the same nasal cavity, separated from the spouting sacs or opening into them only by an extremely reduced orifice. The walls of the part of the case examined consisted of mucous membrane fifteen millimeters thick, with the surface raised into convolutions separated by fissures in such a way as to recall the surface of the brain. The secretion is thus non-glandular and approaches, physiologically, the secretion of wax by the bee. The structure of the case of the cachalot does not recall any organ present among mammals.

PHYSIOLOGY.[1]

THE PHYSIOLOGY OF RUMINATION. — As is well known, the stomach of a ruminant animal is a complex organ consisting of four distinct chambers. Of these the last, that opening directly into the intestine, corresponds functionally to the single stomach of other vertebrates, the other chambers of the herbivorous stomach probably only being concerned in the preparation of food preliminary to digestion. The feeding of ruminants is characterized by the fact that the food when first swallowed passes only as far as the first and largest division of the stomach, the paunch, where enormous quantities may be laid up. When the animal has ceased feeding it seeks a position of rest and then begins a regurgitation by piecemeal of food from the paunch into the mouth, where it is thoroughly masticated, "chewing the cud," after which it is swallowed into the "fourth stomach" for final digestion. It is this process of rumination which Professor Luchsinger has recently studied in the goat.

Attention is called to the fact that the act of rumination is interrupted if the animal is disturbed in the slightest degree. The goats experimented on were narcotized with morphia, which numbs painful sensations but interferes little with reflex action. After appropriate operations, the author was enabled to assure himself that pressure with the hand upon the wall of the paunch brought about in perfectly normal manner the act of rumination, there was first a movement of the vocal cords tending to close the glottis, then the diaphragm contracted so as to press upon

[1] This department is edited by Professor HENRY SEWALL, of Ann Arbor, Michigan.

the upper surface of the stomach, and at the same time the abdominal walls contracted energetically; a morsel of food was thus thrown up rapidly into the mouth, any excess of water in it being pressed out and swallowed; then began a long series of cud chewing movements, at the beginning of which occurred a copious flow of saliva into the mouth; finally, with a swallowing movement the mouth was emptied and the masticated morsel sent back for its complete digestion. The amount of food regurgitated was determined by the sphincter muscles at the cardiac opening of the paunch, these muscles relaxing at the beginning of the act but closing finally again when a small amount of food had been forced out. The whole series of movements was readily brought about by electrical stimulation of the wall of the paunch, or when this was mechanically excited by distension with warm water or by pressure with the hand. Strange to say the flow of saliva and the chewing movements followed in regular order expulsion of food from the paunch, though the morsel was not, in some cases allowed to enter the mouth but was expelled lower down from the divided œsophagus. This artificially excited act of rumination could only be provoked when the pneumogastric nerves were intact.

Luchsinger concludes that rumination is a complex reflex action, the stimulus to which is the distension of the walls of the paunch by the accumulated food matter, the amount of pressure upon the wall being also, no doubt, regulated by the motor nerves of the stomach. The afferent nerves concerned in the reflex are probably the vagi, and these call into coördinated action a number of correlated nerve centers governing salivation, mastication and movements of the vocal and swallowing apparatus.—*Pfluger's arch., 1884, Bd. 34, S. 293.*

Circulation of Blood Corpuscles.—Dr. G. J. Hamilton has made an examination of the physical conditions which affect the movement of solid bodies suspended in a circulating fluid with reference to the analogous case of the blood corpuscles in the living body, and his results are full of suggestiveness in the explanation of many obscure phenomena of pathology. The blood corpuscles are solid bodies suspended in a liquid plasma; the red corpuscles outnumber the white about 300 or 400 to one. It was the aim of the author to determine the relation between the specific gravity of the corpuscles (with respect to that of the plasma) and the circulation of the blood. A stream of water was allowed to flow through a horizontal tube several feet in length, and little balls or disks of wax and other substances of various sizes and specific gravities were dropped into the current and carried along by it. In this simple scheme of the circulation it was found that the balls or disks when specifically lighter or heavier than the fluid were carried along the sides of the tube, in the former case

against the upper and in the latter against the lower side. Friction on the tube wall retarded the motion and gave a rotating movement to the solid bodies which tended to accumulate and clog the bore of the tube.

When the balls were of the same specific gravity as water they were swept along the middle of the tube and remained always in the "axial" or swiftest moving central current without touching the sides. In the normal circulation of the frog it can be shown that the white corpuscles pass along the upper wall of the blood vessel with a rotating motion. In order to make this observation the vessel observed must lie in a horizontal position while the web or sheet of tissue holding it is in a vertical plane. When the blood-vessel twists so that what was once the upper side becomes the under, the white corpuscle, carried on by the current, gradually crosses the stream and reaches the new top wall. These facts are easily explained when it is considered that the white corpuscles are specifically lighter than the blood plasma. The red blood corpuscles move in a crowd, without rotation, away from the vessel wall, in the so-called axial current, which is more marked the more rapid the circulation.

The red corpuscles are specifically scarcely heavier than the plasma, while the white are considerably lighter. The author points out the evident conclusion from his experiments, that the relation between the specific gravities of red corpuscles and plasma must remain during health in very fine adjustment. For were the red corpuscles to become decidedly either specifically lighter or heavier than the plasma, they must crowd against the vessel walls and the frictional resistance thus offered to the circulation might readily exceed the power of the heart to overcome.

It does not seem improbable that a disturbance of the specific gravity of the blood plasma in extensive albuminuria is the direct cause of the inflammations of different kinds, such as pleurisy, pneumonia, &c., to which there is a great tendency in that disorder. The tendency to hypertrophy in the left ventricle of the heart, and to general dropsy, may be explained in the same way.

In Asiatic cholera the water is rapidly drained from the blood, and the speedy collapse may have its solution in the clogging of the blood-vessels with corpuscles that are crowded against their walls.—*Journ. of Physiology, Vol.* v, *p. 66, 1884.*

PSYCHOLOGY.

Emotional Faculties of Animals.—It will be observed, on turning to the diagram, that I attribute to animals the following emotions, which I name in the probable order of their historical development: Surprise, fear, sexual and parental affection, social feelings, pugnacity, industry, curiosity, jealousy, anger, play, affection, sympathy, emulation, pride, resentment, æsthetic love of ornament, terror, grief, hate, cruelty, benevolence, revenge, rage,